

AMATEUR SATELLITE REPORT

AMSAT's Newsletter for the Amateur Space Program.



Amateur Satellite Report is endorsed by the
American Radio Relay League as the special interest
Newsletter serving the Amateur Radio Satellite Community

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ARRL Foundation Votes Phase 3C Matching Fund

At its January 26, 1985 meeting at ARRL Headquarters, Newington, CT, the ARRL Foundation voted in favor of a motion to support AMSAT's Phase 3C construction project. The Foundation voted to:

"Authorize a grant of Ten Thousand Dollars to the AMSAT Corporation, Washington, D.C. as matching funds for the AMSAT Phase 3C satellite launch fund raising effort. This grant will be made available in two payments of Five Thousand Dollars upon confirmation of AMSAT matching fund accomplishments."

In a follow-up letter to AMSAT President WA2LQQ, ARRL Foundation President Paul Grauer, W0FIR, indicated the funds would be transferred to AMSAT as stated in Minute #7 of the Foundation meeting. President WA2LQQ's reply to Mr. Grauer indicated "AMSAT's gratitude for the Foundation's steadfast support of the Amateur Space Program and its ideals as manifested in part by the construction and launch of Phase 3C."

Phase 3C is a joint endeavor of AMSAT and AMSAT DL. The project seeks to prepare for launch an advanced version of AO-10 by mid-1986. (See ASR 98/99).

The ARRL Foundation, Inc., is a separate entity established by ARRL for the advancement of Amateur Radio. W0FIR was recently elected President replacing the retiring Robert York Chapman, W1QV. W0FIR is ARRL Midwest Division Director. The ARRL Foundation had previously provided a matching fund for Phase 3A.

According to WA2LQQ, donations earmarked for the matching fund may be sent to AMSAT, P.O. Box 27, Washington, D.C. 20044. AMSAT will maintain an accounting at its Headquarters Office of funds donated and, when the first \$5,000 increment is attained, AMSAT will apply to the Foundation for the first \$5,000 grant.

Support AMSAT with your donation today! Every dollar you donate now results in two dollars towards Phase 3C!

On the Shoulders of Giants

Editorial Opinion by WA2LQQ

The communication of ideas among and between interested individuals is an important, if occasionally overlooked, function of AMSAT. AMSAT has relied on several means

to accomplish this communication with various degrees of success. The AMSAT Quarterly Newsletter, *Orbit* Magazine and recently *Satellite Journal* and *ASR* have striven to tighten the lines of communication. All have succeeded in filling a niche where previously an evident need existed. All fell (fall) short in one regard or another in bridging the chasm extant between the most complex ideas with which we deal and the most mundane.

AMSAT is a curious admixture of thinkers and doers; of flighty tinkerers and serious students; of competent science and unmitigated tomfoolery; of selfless public service and unabashed, self-aggrandizement. With this diversity of interest, this spectrum of skills, this breadth of topical familiarity, is it any wonder no single publication has completely succeeded in embracing the whole of AMSAT.

We may be a tad too parochial to abide the starkly foreign when it appears in our magazine or newsletter. To the beginner, solutions to differential equations are as baroque as a medieval monastery and somewhat less appetizing. To the seasoned expert, on the other hand, discussions dwelling on the merits of weekly updates to NASA element sets may be somniferous.

What does all this mean? Is he who seeks to please many condemned to satisfy none?

Perhaps. Just perhaps.

Witness the obvious. The technical wizards (let's call them Twizs) recently have been challenged not by the depth of new ideas published in AMSAT's various vehicles, but rather with the pedestrian challenge of merely staying awake while reading them.

The typical NICE guy, (Normal, Intelligent, Communicative, Entity) for his part is often intimidated by exotica appearing in his bill-of-fare. Moreover, he might conclude much of the mumbo-jumbo is merely the jargon of AMSAT's hypothetical "secret" society; the "They" to whom is attributed all those arcane wonders in orbiting little black boxes.

"Why", he plaintively inquires, "need it all be so complex? Is there nothing which can be explained in simple, down-to-earth terms?" Justly he points to the lack of art in our writings "For it is in your art, Sirs, that you make the complex less so!"

Both groups have their points. Yet despite the bleatings of both and the occasionally forceful tactics of their advocates and proponents, we have sought, with various degrees of success, to synthesize the requirements of each into a single publication. We believed, perhaps wishfully, that forged in the symbolism of a single publication lay the key to continued organizational unity. In emphasizing unity, however, we tended to ignore inherent diversity.

Rather than a homogeneous group with largely correlated interests, we find ourselves a lumpy amalgam; an agglomerate; heterogeneous in a very real sense. Why then ought we expect a single publication to suffice? We ought not!

Neither should we despair in the dissolution of symbolic organizational unity manifested in specialty publications for disparate tastes, aptitudes and predilection. A completely adequate organizational model for "e pluribus unum" exists.

The Twizs require a diet of highly nutritious technical hay to sustain the growth of both their personal interest and the technical base of the organization. The NICE folks similarly need a satisfying diet of appetizing things which make sense to them; things like helpful articles on improving station operating, new equipment reviews and tutorials one can understand without requiring an advanced degree in salutary debunkery!

Moreover, why should we conclude that merely two communities (the Twizs and the NICE folks) are all there is? One could argue further a whole new cult of organizers and

managers is emerging. And what about the communicators themselves? The folks who write for *Satellite Journal* and *ASR*? Are they yet a fourth community?

Simply put, we need to develop the communication vehicles necessary and sufficient to meet the present and changing needs of our members. With the proportion of NICE Guys to Twizs now standing at somewhere between 5-to-1 and 20-to-1, the needs of at least 80 percent (4000) of the members could be well served by *Satellite Journal*.

The introduction of the *AMSAT Technical Journal* later this year is an attempt to redress the absence of a suitable vehicle for professional-level papers in the field of Amateur Radio satellites and related space activities. It will be available to anyone who wishes to receive it at a nominal charge. All will be encouraged to subscribe to it. One edition is planned for 1985. If successful, perhaps as many as two editions will be forthcoming in 1986.

The strength of an organization lies as much in its diversity as its vision and purpose. Inasmuch as the fundamental vehicle for our major activity (using satellites) is the satellites themselves, it seems perilously short-sighted to not nourish the minds which conceive these marvelous contraptions. Conversely, by stimulating new ideas, approaches and talent with an advanced communication vehicle such as the *AMSAT Technical Journal*, we can only enrich the soil in which brilliance may come to flourish!

Welcome the new *AMSAT Technical Journal*, soon to take its place alongside AMSAT's flagship publication, *Satellite Journal*.

Short Bursts

- In *ASR* 98/99 we stated the new, yet unnamed mode on RS-10 would have a beacon on 145.957 MHz. We erred. We should have said 145.997 MHz instead. Thanks G3IOR.
- Pat also points out the AO-10 GD DXpedition will be "Manned" by G3CUO and G4ZHG rather than G4CEO and ZHG as reported. Thanks for this correction too.
- Eric Rosenberg, WA6YBT, is seeking to establish a photographic base for a paper on AO-10 operations. He is seeking good quality slides of various stations to include in this presentation. If you would care to loan a slide or two to Eric, please send your 35 mm slides to Eric Rosenberg, 1467 Beaverton Drive, Dayton, OH, 45429. All materials will be returned later. Thanks from Eric!
- WA6VGS has appointed a new group of Area Coordinators. In random order they are: Bill Parris, N5ARS, AC for Arkansas; Paul Beeman, KA2MUM, AAC for Long Island, New York; Byron Lindsey, W4BIW, AC for Georgia; Frank Dzuirda, K7SFN, AC for Northern Nevada; David Brunette, WA1AYT, AC for Maine; George Tew, NC5Y, AAC for Mississippi; John Low, K3JL, AC for Delaware; and Tim Kearney, NZ4Q, AAC for Indiana (transferred from Georgia). Congratulations to the new appointees!
- GBØAUK (formerly GB2RS) news broadcasts on AO-10 SSC H2 are scheduled as follows: 12 May, 0600; 19 May, 0200; 26 May, 0830; 2 Jun, 0600; 16 Jun, 0800; 23 Jun 0130; 7 Jul 0530; 14 Jul 0030. All times are in UTC. Tks G3IOR.

N2CF Departs As ED/GM

In a short message to the AMSAT Board of Directors and Officers dated March 26, 1985, AMSAT's Executive Director and General Manager Bill Lazzaro, N2CF, announced his withdrawal from further direct involvement with AMSAT business. He cited "responsibilities in my position with the ARRL which have the potential for a clear conflict of interest" as the reason for his departure from the scene.

N2CF accepted the post of Development Manager for ARRL in January and at that time stepped down as one of AMSAT's two salaried employees. (See *ASR* #94/95) He remained on, however, as nominal ED/GM while in the ARRL's employ until now. AMSAT has no immediate plans to seek a replacement although the subject does appear on the April Board Meeting agenda according to Chairman W6SP.

Call For Papers

AMSAT, The Radio Amateur Satellite Corporation, Inc., has issued a call for professional papers reporting original work and/or significant findings in the field of low-cost satellite engineering, space communications, space sciences and related social value issues. A list of suggested topics is provided below. The list is not comprehensive.

Accepted papers will be published in the premiere edition of *The AMSAT Technical Journal* which has a publica-

tion date of December 1, 1985. Approximately 12 to 15 papers are anticipated to be published in the premiere edition.

Papers are due before August 1, 1985 and should be mailed to: AMSAT Technical Journal, P.O. Box 27, Washington D.C., 20044.

Suggested topics include:

Telecommunications including telemetry encoding schemes, command and control, ranging, tracking, modem design, modulation schemes, communications theory; analog voice processing techniques such as ACSSB; digital voice encoding techniques such as LPC-10, APC and CVSD modulation; packet radio techniques with emphasis on higher order networks; intermeshed terrestrial and space-nets; gateway/teleports; application/adaptation of cellular mobile radio switching technology; mobile satellite communications; solid state power amplifiers for space use; very low noise pre-amplifiers; antenna design including active phased arrays; use of SHF and above; computer sciences applications including tracking programs with emphasis on speed and graphics capabilities; telemetry processing, analysis and display; orbit modeling and optimization techniques; space sciences including ionospheric physics, geo-magnetics; mechanical engineering including active and passive thermal control systems, structures; propulsion systems with special emphasis on low-risk, low-cost approaches; active and passive attitude control systems, radiation hardened systems; reliability engineering and modeling for space applications; system architecture; social-value issues; emergency communications; geo-synchronous concepts; inter-satellite crosslinks; power conditioning systems; ultra-high efficiency, long-life solar cells and specialty coatings; advances in battery design.

Papers must contain a one paragraph abstract and be limited to 10 pages maximum including graphs, tables and references. An author's guideline information sheet is available from AMSAT at the address above. Papers submitted for consideration should not have been previously published. Specific exceptions can be made in certain special cases.

In addition, an outstanding group of professionals has been named to insure the authenticity and accuracy of materials appearing in *The AMSAT Technical Journal*. Those already named to the Editorial Advisory Board include:

Dr. Mario Acuna, LU9HGB, NASA
 Dr. Thomas A. Clark, W3IWI, NASA
 Dr. Martin Davidoff, K2UBC, Catonville College
 Dr. Al Dayton, KA4JFO, International Mobile Machines
 Dr. John DuBois, W1HDX, Dytron-Thermologic
 Dr. Owen Garriott, W5LFL, NASA
 Mr. Richard Jansson, WD4FAB, (retired from Martin-Marietta)
 Mr. Phil Karn, KA9Q, Bell Communications Research
 Mr. Jan King, W3GEY, Skylink, Inc.
 Dr. Perry Klein, W3PK, Washington Cable
 Dr. Robert Leonard, KD6DG, SRI International
 Dr. Robert McGwier, N4HY, Auburn University
 Dr. Henry Magnuski, KA6M, Gamma-Tech
 Mr. Harold Price, NK6K, PACSAT
 Dr. Steve Robinson, Hahnemann Medical Center
 Dr. Cleyon Yowell, AD6P, The Aerospace Corporation

Revised Phase 3C Mode S Proposal

Special to ASR by Bill McCaa, KØRZ

Background

I believe the addition of an S-band transponder on Phase-3C would help the transition of the average satellite user to microwave frequencies. The ready availability of good low cost receiving equipment in the MDS (2150-2160 MHz.) service can find immediate application to receiving a Phase-3C transponder in the 2400-2450 MHz. band. The Colorado group is quite excited with the prospect of building this transponder.

Considering the presently available transistors and the power budget of the spacecraft, I propose that the transponder be hard limiting, and have an average power output of 2 Watts. The bandwidth would be about 20 kHz which would be suitable for transponding a single narrow band FM signal and allow for Doppler and other frequency errors.

I propose that this transponder be called the Mode-S transponder.

Link Calculations at 2.4 GHz

Transmitter output power at antenna	+3 dBW
Spacecraft antenna gain (8 turn helix)	+14 dBic
Spacecraft EIRP	+17 dBW
Free space path loss (40,000 km ² 2.4 GHz.)	-192 dB
Signal level at receive antenna	-175 dBW
Receive antenna gain (1 meter dish ² 50)	+25 dBic
Signal level at receiver	-150 dBW
Receiver sensitivity (75K, 20 kHz.BW)	-160 dBW
Received signal to noise ratio	+10 dB

A 10 dB signal to noise ratio would constitute a minimum but useful signal level for FM communications.

Implementation in Phase-3C

The S band transponder would use a portion of the mode-B transponders receiver. A buffered output at 53 MHz would be needed following the mode-B receivers first mixer. The transponder would be operated only when the mode-B receiver is active. The following details the frequencies used in the S band transponder.

Input frequency to the S band transponder	435.210 MHz
Input frequency from Mode-B transponder	53.250 MHz
Local crystal controlled oscillator (LO)	41.930 MHz
IF frequency including filter (IF)	11.32 MHz
IF filter bandwidth	20 kHz
1st upconversion frequency (F1=3XLO+IF)	137.11 MHz
2nd upconversion frequency (Fout=54XLO+FI)	2401.33 MHz
Output frequency from the S band transponder	2401.33 MHz

The spacecraft antenna would be a left hand circular 8 turn helix that could be counter wound around the omni antenna and inside the 1269 helix. The power drain at 14 volts should be less than 10 Watts. Transponder placement is yet to be determined but could be configured to fit in an arm of the spacecraft close to the arms outside edge. Placement in ARM-1 next to the mode-B and mode-L receivers is a possibility. Jan King has offered to locate and

size the possibilities for the placement of the transponder in the spacecraft.

General Comments on Use

The transponder could be used for bulletin services, as well as normal voice and data communications via the narrow band FM channel.

The ground station receiver could use AFC to overcome receiver drift and Doppler. The transponder downlink channel would be easily located as a near constant output signal (2 Watts) would be present at all times. For example with no signal input, the downlink signal would be soft limited noise (approx 6 dB down from hard limit) distributed across the 20 kHz downlink channel. With the downlink channel identified, the uplink transmitter frequency could be adjusted by the user so as to be centered in the downlink channel. A squelch system will be incorporated that would defeat the transmitter whenever the transponder uplink frequency was inactive for more than one minute.

S-Band (Mode-S) Transponder Functional Block Descriptions

The following describes the functional blocks for the S-Band transponder. With the exception of the local oscillator signals, signal flow it from left to right and top to bottom on the page.

Mode-B Transponder Receiver output

Input freq. = 435.225 MHz
Input signal level = -107 dBm
Mode B internal gain = +26 dB
Mode B output freq. = 53.265 MHz
Mode B output level = -81 dBm
Drives 1st Mixer
Already contained in the Mode-B transponder, but will require an additional 53 MHz output port.

VHF 1st Mixer

Input signal level = -81 dBm
Input freq. = 53.265 MHz
Mixer gain = +20 dB
Output signal level = -61 dBm
Output frequency = 11.32 MHz
LO input freq. = 41.93 MHz
LO input level = -20 dBm
Driven by the 1X port of the LO
Driven by the Mode-B output port
Drives the IF filter

IF Amplifier/Limiter

Input signal level = -71 dBm
Input freq. = 11.32 MHz
Stage gain = +35 dB
Output signal level = -36 dBm
Output frequency = 11.32 MHz
Driven by the IF filter
Drives the VHF 2nd mixer
Control is provided to the S-band power amplifier for transmitter shutdown one minute after the absence of signal.

Local Oscillator (LO)

Xtal freq. = 41.93 MHz
1X output level = -20 dBm
3x output freq. = 125.79 MHz
3X output level = -20 dBm
54X output freq. = 2.26422 GHz
54X output level = > +6 dBm
Drives VHF 1st mixer with 1X
Drives VHF 2nd mixer with 3X
Drives S-band mixer with 54X

IF Filter

Input level = -61 dBm
Input/output freq. = 11.32 MHz
Filter gain = -10 dB
Filter bandwidth 3 dB = 20 kHz
Filter bandwidth 60 dB = 25 kHz
Driven by the 1st mixer
Drives the IF amplifier/limiter

VHF 2nd Mixer

Input level = -36 dBm
Input freq. = 11.32 MHz
Mixer gain = +6 dB
Output signal level = -30 dBm
Output freq. = 137.11 MHz
LO input freq. = 125.79 MHz
LO input level = -20 dBm
Driven by the 3X port of the LO
Driven by the IF amplifier/limiter
Drives the VHF amplifier

VHF Amplifier

Input signal level = -30 dBm
Input freq. = 137.11 MHz
Stage gain = +20 dB
Output signal level = -10 dBm
Output frequency = 137.11 MHz
Driven by the VHF 2nd mixer
Drives the VHF 2nd mixer

S-Band Power A

Output signal level = +3 dBW
Output frequency = 2401.33 MHz
Driven by the S-band mixer
Drives the S-band helical antenna

S-Band Mixer

Input level = -10 dBm
Input freq. = 137.11 MHz
Mixer gain = -4 dB
Output signal level = 0 dBm
Output freq. = 2401.33 MHz
LO input freq. = 2264.22 MHz
LO input level = +6 dBm
Driven by the 54X port of the LO
Driven by the VHF amplifier
Drives the S-band power amp.

A meeting to discuss, modify, and define work assignments relative to the revised proposal and functional block diagram for the S-band transponder was called by KØRZ and attended by W3GEY, KE3D, KØRZ, AAØL, WAØVSL, KDØWM. It was held in Colorado Springs, CO on March 31. It was decided to advance the proposal through the design phase and to pursue the development of the transponder as quickly as possible. The following work assignments were agreed upon. The goal is to complete the first pass preliminary design by the next meeting on May 5, 1985. The designs should include:

- 1 - The power required at 14 volts.
- 2 - The physical volume and weight.
- 3 - The circuit.

Task Area

Project Coordination
S-Band Mixer
Local Oscillator/Multipliers

Intermod Study
VHF Mixers, IF Amp/Limiter

Placement in Spacecraft
S-Band Power Amplifier
(Tentative)
(Tentative)

Responsible Persons

Bill, McCaa, KØRZ
Brad Bradley, KDØWM
Ray Uberecken, AAØL
Steve Ernst, WBØWED
Brad Bradley, KDØWM
Gordon Hardman, KE3D
Bill McCaa, KØRZ
Jan King, W3GEY

Charley Mangus, WØVN
George Noyes W1XE

The next meeting will be on May 5, 1985 in Boulder, CO with the purpose of discussing the functional designs completed and the integration of the designs of the component blocks.

ZRO-Tech Award Dry-Run Initiates New Awards Program

As previously announced in these pages, the ZRO-Memorial Station Engineering Award is a component of AM-SAT's new Technical Achievement Awards Program. The objective of the ZRO-Award is to encourage better station receive capabilities. This is accomplished through on-the-air tests wherein calibrated signals are sent via the transponder at successively lower levels. An individual qualifies for the basic award or a subsequent endorsement by demonstrating his ability to successfully copy the cw code groups sent at various low amplitudes. Signal strength is referenced to the beacon.

The first dry-run was held on Sunday, 7 April at 1730 UTC. The satellite was over the mid-Pacific so coverage was in-

complete. The signals were originated at WA2LQQ using a special arrangement of spectrum analyzers, preamps, splitters, attenuators and receivers. The beacon level was displayed. Next a test signal downlink equal in amplitude to the beacon (as heard at WA2LQQ) was generated. This reference level was denoted by a series of cw "0"s. Next the amplitude was reduced by 3 dB and a series of "1"s was sent indicating the level was "1" increment (3 dB) below the beacon. Next, transmit power was again reduced to produce a downlink signal 6 dB below the beacon. A series of cw "2"s denoted that level. The process was repeated through levels 9, 12, 15 and 18 dB below the beacon. These levels were indicated by cw signals of "3", "4", "5" and "6" respectively. At WA2LQQ the ERP required to generate a signal 18 dB below the beacon was approximately 10 watts ERP. This downlink was not copyable at WA2LQQ while level 5 (beacon - 15 dB) was partially copyable. The CW was machine generated using an AEA MBA-RC and keyboard.

For the actual test runs next month, a slightly different protocol will be used. As before the levels will be indicated by a series of exactly five numeric characters. For example, the string "44444" would indicate the test sequence to follow is 12 dB below the beacon. The actual test message will be a random group of exactly 5 numeric characters repeated exactly three times. The test group of five characters will be different for each test level and for each test session. The test character group can be distinguished from the level markers characters in that the latter five character group has all five characters identical, e.g., "44444".

A typical test sequence might proceed thus.

00000	00000	00000	72518	72518	72518
11111	11111	11111	94220	94220	94220
22222	22222	22222	31965	31965	31965
33333	33333	33333	44336	44336	44336
44444	44444	44444	80123	80123	80123
55555	55555	55555	09172	09172	09172
66666	66666	66666	56340	56340	56340

If the participant correctly guessed 80123 for level 4 but missed at 09172 for level 5, he would receive the basic ZRO-Award plus all endorsements down to beacon minus 12 dB. Endorsements will be attractive stickers for affixing to the basic certificate. An individual can qualify for the basic award using either Mode B or Mode L. A nominal processing fee will be assessed to offset the cost of the certificate and handling. The exact amount will be determined after the certificates are in hand.

The first two Mode B test runs for the ZRO-Memorial Award are scheduled as follows:

Day	Date	Time	MA	PA	Az	El	SSP	Notes
Sun	5 May	1130	106	9	182	42	0N, 76W	1,2
Fri	24 May	1015	108	9	179	39	25, 73W	

Notes:

1. PA is pointing angle; the off-bore sight angle from WA2LQQ at the test epoch. Chosen to minimize spin modulation. Near apogee also chosen to broaden coverage and reduce range differences between contestants (to normalize path loss).

2. Az and El are from WA2LQQ only.

Report forms will be available from AMSAT shortly.

Spring Satellite Bulletin Schedule Announced

The spring schedule for the satellite bulletins has been announced. The voice bulletins will appear on Special Service Channel (SSC) H2, nominal downlink frequency of 145.962 MHz.

Btn#	Day	Date	Time	Orbit#	MA	SSP
14	Sun	14 Apr	1500	1381	124	1S, 102W
15	Sat	20 Apr	1200	1393	148	6S, 52W
16	Sat	4 May	1400	1422	146	8S, 96W
17	Sat	11 May	0600	1436	75	6N, 12W
18	Sat	18 May	1400	1451	100	0N, 128W
19	Sat	25 May	1300	1465	183	17S, 82W

Bulletins normally last 10 to 12 minutes and are followed immediately by orbital predictions. Bulletins are currently transmitted using 2:1 amplitude compression. A 4:1 compression rate will be implemented using a modified STI ACSB radio later this spring. Recovery techniques using expanders of complimentary rates will enhance audio quality and intelligibility.

Mode L bulletins are planned to begin in May. Initial downlink frequency is 436.280 MHz, USB. Mode L will eventually employ ACSB as well as Mode B.

PACSAT Meeting Minutes Offered

Compiled by PACSAT Program Manager Harold Price, NK6K

Minutes of PACSAT Design Review Meeting
VITA Headquarters, Arlington, VA
Goddard Space Flight Center
March 9-11, 1985

Thanks to Paul Rinaldo for his assistance in the preparation of these minutes.

Present were:

John Biro, K1KSY, AMSAT
Ed Brandon, International Development Research Centre, Ottawa
Dr. Thomas A. Clark, W3IWI, Director, AMSAT
Richard Daniels, W4PUJ, AMSAT
Rick Fleeter, WA8GVK, Propulsion Systems
Dr. Gary Garriott, WA9FMQ, VITA Technical Advisor
M. Stephen Hodgart, University of Surrey
Anne Heyniger, VITA Resource Development Manager
Lyle V. Johnson, WA7GXD, digital systems design
Phil Karn, KA9Q, AMSAT
Dick Kutz, KS3Q, Goddard SFC
Richard Kerr, Canada
Jan A. King, W3GEY, Vice President, Engineering, AMSAT
Larry Kayser, W3ZIA, Ottawa group
Stan J. Kazmiruk, VE3JBA, Ottawa group
William McAlister, W3AUN, Goddard
Henry Normal, VITA Executive Director

Hugh Pett, VE3FLL, Ottawa group
Harold Price, NK6K, PACSAT Project Manager
Bill Reed, WØETZ, Ground station design
Paul L. Rinaldo, W4RI, ARRL Publications Manager
Robert Stricklin, N5BRG, Ground station design
Dr. Martin Sweeting, G3YJO, UoSAT Program Manager
Jeffrey W. Ward, K8KA, ARRL Laboratory Engineer
Jean Wilkowski, Chairman, VITA Board of Directors
David MacQuarri, CBC Reporter

Dr. Gary Garriott: Opening Remarks

Jean Wilkowski: Conference Objectives

- Technical refinemen & definition
- Exact budget?
- Big name/benefactor to attract people to idea and money

Henry Norman: VITA Mission and PACSAT

- VITA is involved in appropriate technology -- latest, not basic.
- Trying reach people at village level.
- Concerned about how technology is transferred and applied.
- Emphasized interest in communications -- PACSAT is an important part.
- Ethiopia could use PACSAT now.
- Promised that VITA would find funds.

Harold Price: Conference Focus

- Primary problem is funding.
- Confident that electronic package for a meaningful proof of concept can be developed that will fit in a GAS can.
- Launch services agreement must be at NASA in Jul 1985, to maintain our place in the reservations list.

Lyle Johnson: PACSAT-Related Activities in Tucson and TAPR

- Description of El Paso GAS-can experiment controller.
Took on the job to gain experience that would be useful in PACSAT project.
Used NSC800 microprocessor and 128-kbyte mass storage - gain experience windowing in memory.
- TAPR involved in design of UoSAT 2 Data Communications Experiment (DCE).

Larry Kayser: Ottawa Activities

- Commented on his trip to Hawaii at which he demonstrated packet radio through UoSAT DCE at the Pacific Telecommunications Conference. Got message to UoSAT and received answer from Surrey using DCE.
- Wants to get demonstration in Third World country.
- Performed PACSAT memory experiments to reduce power drain.
- Received new CMOS memory chips from Lyle Johnson.
- Wants to be battery clearing house - has test facilities.
- Prototype of large memory array is ready to build, funding required for parts.

Dr. Martin Sweeting: University of Surrey Activities

- Working on UoSAT DCE and higher data rates.
- First DCE demo in Jan 85.
- Harold Price to get improved software (when ready) into DCE.
- In March, will release functional description on TELENET.

Bill Reed: Dallas Projects

- VITA HQ/AMSAT Command station -- fully automated, crossed Yagis on az/el mount, high power (100 W+), large storage and processing, 10-Mbyte Winchester IBM PC
- VITA regional center/AMSAT gateway -- Xerox 820, 50 W
- VITA end user -- suitcase, ground-plane antenna, 10 W, lap computer (e.g., RS Model 100), solar powered, all CMOS.
- In common to all of above stations: 9600-Bd TNC, frequency- agile radios to select uplink channel and compensate for Doppler.
- Need demo package ASAP.
- Stress need for hard copy in demo package.

Phil Karn: PACSAT Modem System

- Operates BPSK at 300-9600 Bd, laid out on 4 X 5-in PC board.
- Costas-loop demodulator is a power hog needing redesign.
- Hasn't done BER testing - needs help.
- Thinking about adding data scrambler similar to that of Steve Goode, K9NG.

Anne Heyniger: PACSAT Funding

- Best news on funding was Herbert (Pete) Hoover III, who very interested in relief -- American Red Cross, Int'l Red Cross.
- Tektronix Foundation gave \$5 k.
- Expect money from UN/PADAS, headquartered in Addis.
- UNEDO, Vienna, pledged \$5 k.
- Public information is out, but money has not come in.
- Hoover suggested his foundation will entertain \$40-50 k proposal from VITA for PACSAT fund-raising consultant.
- Current prospects: AT&T (DC), Fairchild (VA), Keck Foundation (CA), Lockheed (CA), RCA (NY), Rockefeller Foundation (NY), TRW (CA).
- Harold Price says that \$15 k is available now for hardware.
- Funds for Harold Price came from AID.

Paul Rinaldo: FCC Licensing

- Group was confused on responsibility for dealing with FCC.
- Licensing paperwork has been filed and is in FCC's court.
- VITA would like to know status.
- ARRL willing to take point on FCC liaison but need timely technical information, which to date has been slow coming.

- There was consensus for periodic Williams/Garriott/AMSAT rep meetings to coordinate liaison with FCC.

Harold Price:

Discussed various orbit possibilities (97, 26, 57 degrees).

- Garriott defined VITA needs orbit to cover not only equatorial areas but VITA Headquarters, Wash, DC.
- Rinaldo recommended VITA consider HF and VHF packet for in-country packet radio.
- Consensus was to target for high inclination orbits (greater than 57) as low inclination orbits had too many negative effects on command and control functions.

Rick Fleeter: PACSAT Propulsion System

- Discussed propulsion system requirements, design, and construction. Initial design study is complete, design of the first prototype is underway.

Jan King: Spacecraft Main Problem Areas

- 57-degree orbit will require work in the thermal control area to protect batteries.
- Fast-acquisition demodulator capable of locking in few ms.
- Gravity-gradient boom competes with volume for electronics and position for second thruster.
- Prefer octagonal (to cylindrical) shape as it easier to mount replace solar cells. Tank would be cylindrical, so corners of octagon used for wiring channels.
- GAS-launched spacecraft is volume limited not power limited.
- For program to succeed, need managers for:
 - Spacecraft bus
 - PACSAT instrument
 - PACSAT user equipment
 - Command/control station
- Sees as two-year program

Dr. Martin Sweeting: Design Considerations

- Feels that PACSAT should pursue both Shuttle and expendable-vehicle launch opportunities. Shuttle GAS-can configuration necessitates use of unproven designs. Expendable-vehicle launch would permit use of proven hardware.
- Reported experiments with several BPSK modem designs which showed difficulty getting them to work and be replicable, even in tens.
- Using UoSAT-Oscar 11 as a test bed for modem development.
- Has 2400-Bd AFSK-PM modem routinely working.
- Despite general dislike of programming RCA 1802 microprocessor, there is much UoSAT spacecraft control software for it.

Phil Karn, KA9Q: BPSK 9600-Bd Modem

- Everything works except Costas loop, to reduce power consumption.

- Needs help doing PC layout. Surrey agreed to handle.
- First few will require lots of tweaking. Reproducibility has not yet been determined.
- Plans to have modem built into the radio so users can just plug unit into TAPR TNC.
- Tom Clark asked whether Steve Goode, K9NG, 9600-Bd FSK modem could be used for uplink. Harold Price estimated a 6-dB penalty for FSK. Additional uplink power could be supplied by amplifier with small heat sink because of low duty cycle.
- Harold Price proposed use of the microprocessor present in every ground station to determine transmit frequency. Jan King favored solving fast frequency-acquisition circuitry for satellite.

M. Stephen Hodgart: Modulation and Coding

- Assumptions:
 - Constant-envelope power
 - Capable of reception with ordinary receiver
 - Minimal bandwidth/maximum roll-off away from carrier
 - Potential S/N performance near that of BPSK
 - Demodulates independent of bit sequence
- BPSK can be filtered (Feher). Linearity needs to be maintained after modulation or effects of filtering destroyed.
- PM-FSK is not optimum but it works.
- PFM-MSK uses 1/2 cycle of frequency for one state, 1 cycle for the other state. It is not purely FM or PM. DC free. No level or slope discontinuities. Any bit pattern can be demodulated. Produces good eye pattern with coherent receiver.
- Showed cumulative power spectra for different modulation schemes. PFM-MSK is particularly good recovering after fades, regardless of pathological bit sequence.

Lyle Johnson: New Technologies since 1983 Boston Meeting

- Can pack a lot more memory in same space and with lower power than two years ago. One CMOS serial input/output (SIO) chip does the same job as 35 chips to do HDLC encoding and decoding.
- Larry Kayser said that overall memory board is half the size of that flown in UoSAT 2/OSCAR 11.

Harold Price: Design Discussions

- PACSAT to be designed for GAS can. (See paper by Jan King, S/C Main Problem Areas for drawing of internal construction.)
- Diameter to be 19" (corner to corner of octagon).
- Battery compartment to be 4 in high.
- Tank to be 4-1/2 in high.
- Electronics boxes may be trapezoidal segments of octagon, based on further study by Surrey.

Meeting at Goddard Space Flight Center with Mr. Clarke Prouty, Technical Liaison, Gas Program, GSFC and Ms. Donna Miller, Gas Program, NASA HQ

- Cost of a gas can with deployment mechanism and Motorized Door Assembly is estimated to be \$20,000

- Standard GAS procedures do not include clean room facilities during the final payload integration.
- The next GAS experimenters conference will be October 8 & 9, 1985.
- The group inspected the GAS deploy mechanism, the NUSAT spacecraft, and several standard GAS cans.
- The importance of submitting the Payload Accommodations Requirements document and the Launch Services Agreement were repeatedly stressed.

Action Items

- Phil Karn to contact JAS team about thermal implications of the 57 degree orbit.
- Phil Karn to send the result of his modem research and current designs to Surrey for implementation.
- Phil Karn to send K9NG modem designs to Surrey.
- Larry Kayser to send DCE non-flight batteries to Dallas for ground station development.
- Tom Clark to send TELEMAIL command summaries to all users.
- Surrey will refine spacecraft mechanical design details.
- Kayser will start flight battery testing as soon as batteries received (takes 18 months).
- Tucson will do PACSAT instrument design, CAD, and prototyping, by December 1985.
- Engineering design review to be held in January 1986.
- Ottawa will begin flight hardware fabrication by before May/June 86.
- Software team will devote next 3 months to UoSAT 2 DCE testing and will work on PACSAT software after PACSAT hardware better defined.
- ARRL lab will complete the microprocessor az/el controller being designed by Jon Bloom, as it appears to be ideal for PACSAT demonstration unit. (Larry Kayser stressed need for RFI-tight box.)
- Surrey will continue its modem experiments and compare results with Karn (BPSK) and Goode (FSK) designs.
- Harold Price to institute regular status reports to and from all team members.